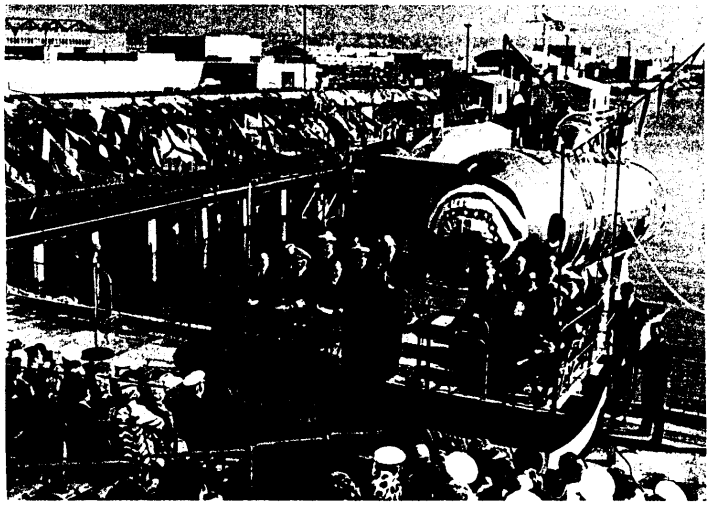
DSRV SPECIAL

Rescue Submarine Is Christened, Launched



E. P. WHEATON, vice president and general manager-R&DD, is master of ceremonies at launching of DSRV-1.

THE LOCKHEED
LOCKHEED MISSILES & SPACE COMPANY

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From the DSRV Manager

by R. W. "Bob" Kermeen, Program Manager

During its evolution — from early preposal days through system test and launch — many groups and individuals have contributed to the progress of DSRV.

Like other hardware programs at LMSC, DSRV has been characterized by complexity and the advancement of technology. Unlike many programs, however, DSRV was a learning experience for a new organization and a relatively young customer entity.

Yet the challenge of designing a manned vehicle—prototype of a new class of submersibles designed to conduct complex rescue, search and research operations in the sea — was met with dedication and competence by all on the DSRV team.

Four years ago, in January 1966, Lockheed's final presentation was made to the Navy proposal evaluation board. Three years ago, on 24 January 1967, the final Design Engineering Inspection was conducted by DSSP and NavShips.

There were no distinct milestones marking the transition from design through fabrication, final assembly, to factory test, but these phases of the pro-

(Continued on Page 6)

R. W. "Bob" KERMEEN, program manager of DSRV, pauses after launch ceremonies.

COLOR GUARD, bearing Stars and Stripes and Navy flag, move into position.

A Ceremony Calls for Lots Of Work Behind the Scenes

Navy tradition for launching a vessel involves much more than just putting it in the water. A ceremony is in order, highlighted by the vessel's sponsor smashing a bottle of champagne across its bow. And there must be a speaker to put into words everyone's hopes for the success of the vessel.

The ceremony seems simple enough, but as with many things that appear simple, the behind-the-scenes preparations are complex as the details are worked out in undramatic hard work.

Lockheed Ocean Laboratory (LOL) at San Diego — home of Deep Quest and its support ship Transquest — the week before the DSRV-1 launching was a hustle with activity.

LMSC personnel from the DSRV Project Office at Sunnyvale and those at LOL, together with the Navy DSRV-1 crew headed by Lt. Cmdr. D. P. Raetzman, worked endlessly to insure that all was ready for the ceremony on Jan. 24.

They hovered around the DSRV-1, nestled in its land cradle on the marine railway, poised above the waters of Harbor Island in San Diego Bay. They made adjustments on the boat, and the day before the ceremony, pushed it out of the Terminal Building to the launching ramp so

(Continued on Page 6)

Navy's First-of-a-Kind Goes to Sea at LOL

The inhospitable world of the submariner promises to become less dangerous with the recent launch of the Navy's first deep-diving rescue submarine at the Lockheed Ocean Laboratory (LOL) in San Diego.

Developed by LMSC, the Deep Submergence Rescue Vehicle (DSRV-1) is the first rescue submarine ever built for any navy. The 49-foot-long vessel is the primary element in a system which will respond to a distress call anywhere in the world and rescue the survivors of disabled submarines.

In a colorful ceremony on Jan. 24, 1970, the DSRV slid down a marine railway and into San Diego Harbor.

Mrs. O. D. Waters, Jr., wife of Rear Admiral Waters, Oceanographer of the Navy, sponsored the DSRV and performed the traditional champagne christening.

The DSRV is now beginning tests and diving trials which will extend into 1971. The Navy will take official delivery of the rescue sub this fall. The boat will be operated by Submarine Development Group One in San Diego.

Rep. Bob Wilson (R-Calif.), principal speaker at launch ceremonies, said that DSRV-1 is evidence that the United States has made significant progress in ocean technology.

He pointed out that the DSRV must perform the most exacting tasks of finding, mating, and rescue ever attempted, and the vessel must also be transportable by aircraft, land vehicle and "piggyback" aboard nuclear submarine.

Navy officials associated with the DSRV program have called the vessel the most advanced deep submersible in existence. Many new materials and components have been developed for its construction.

An integrated control and display (ICAD) system developed by the Massachusetts Institute of Technology provides DSRV operators with data from several sensors, including sonars and TV cameras, and enables them to perform the precision task of sealing their vessel to a submarine's escape hatch.

Vertical and horizontal thrusters on the DSRV enable the submarine's operators to hold their craft in position over a stricken vessel despite currents in the water. By pumping mercury between trim and list tanks, DSRV operators may roll and pitch their craft to match the angle at which the downed sub

CHAMPAGNE FIZZES as Mrs. O. D. Waters, Jr., christens DSRV-1.

lies on the ocean floor. The DSRV can mate with a sub and complete a rescue at angles up to 45 degrees.

The DSRV has a free-flooding outer hull made of glass-reinforced plastic. This surrounds an inner pressure hull of three interconnecting, seven-and-a-half-foot spheres. The high strength HY-140 steel of the pressure hull has never before been used in submarine construction.

The forward sphere of the pressure hull holds two DSRV operators and the ICAD. Two aft spheres hold a third crewman and up to 24 rescuees. The transfer skirt, which must be sealed over the downed sub's escape hatch, is attached directly below the mid pressure-hull sphere.

How It Began...

"That great depth is called the ocean; the Holy Bible calls it the Great Abyss, the place where there is an infinite accumulation of water and depths which are bottomless . . . . . ."

Written five centuries ago, these words express the awe with which man regarded the tremendous bodies of water surrounding his continents. Yet he was compelled to explore them; and over the centuries, he sought to master these seas. With strong navies and enterprising merchant fleets, the world was opened, and whole nations rose to political and commercial supremacy.

As the economic and defense needs of these nations increased, interest in the ocean shifted — notably during the past decade or two — from the surface into its depths. The U. S. Navy — whose traditional mission has been to operate on, from, and in the sea — has continuously accelerated its technological efforts in sub-surface operation.

A significant mark of this interest occurred on January 23, 1960, when the Navy's Trieste descended to 35,800 feet in the Pacific Ocean's Mariana Trench.

The bathyscaph Trieste is an effective deep sea research submersible but it is not designed for extensive endurance, maneuverability, and payload. The need for such capabilities became acutely apparent with the tragic loss of the submarine Thresher in 1963.

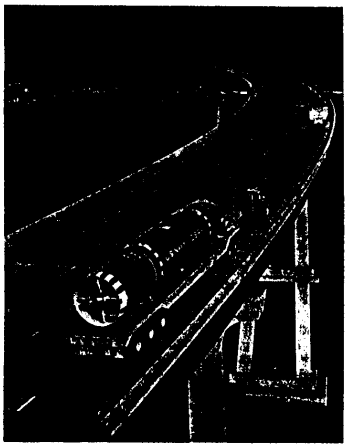
That disaster led to the establishment in the same year of an ad hoc advisory group known as the Deep Submergence Systems Review Group.

Headed by Rear Admiral E. C. Stephan, USN, the Review Group set about analyzing naval capabilities in the ocean environment, and recommending appropriate changes in Navy operational capabilities and future plans. After months of intensive study, it submitted its report in March, 1964.

In that report, the Review Group pointed out that existing systems for the recovery of sunken objects and rescue operations were totally dependent upon surface ships and support equipment, imposing severe limitations. The Review Group therefore recommended that the Navy begin a program to improve its deep sea search, rescue, salvage, and diving capabilities, and the Deep Submergence Systems Project was established in June of 1965.

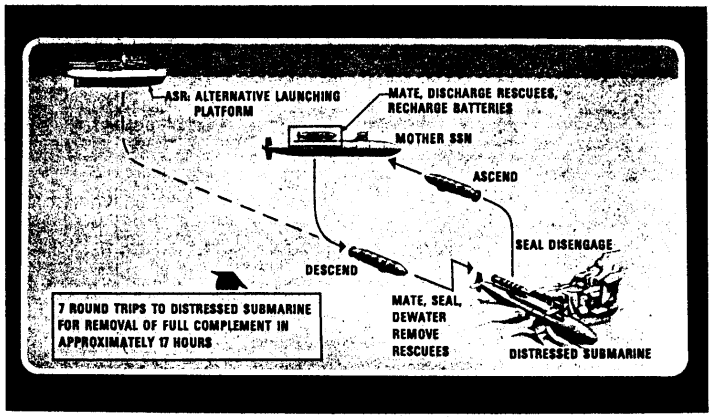
One of the programs assigned to the Deep Submergence Systems Project has been the development and construction of a Deep Submergence Rescue Vehicle (DSRV).

DSRV-1 was built at LMSC's Sunnyvale facility. On Jan. 24, 1970, at 11 a.m., it was christened and launched at the Lockheed Ocean Laboratory in San Diego.



DSRV-1 crosses San Diego's Coronado Bridge on its way to Lockheed Ocean Laboratory.

The Rescue Beneath the Sea



The Deep Submergence Rescue Vehicle (DSRV) is a bold approach to the problem of rescuing the crew of a submarine disabled on the ocean floor. DSRV is designed to mate with such an immobilized submarine and transfer up to 24 passengers per trip to a nearby "mother" submarine or surface ship.

Upon notification that a submarine is disabled, the DSRV and its support equipment will be loaded aboard three C-141 aircraft and flown to a port nearest the disaster scene.

At that port, the DSRV will be loaded aboard a "mother" submarine or a surface Submarine Rescue Ship (ASR), whichever is more readily available.

When carried aboard a mother submarine, DSRV rides "piggyback" on its afterhatch. The mother submarine then proceeds to the disabled submarine and becomes an underwater base to which the DSRV transfers personnel from the disabled submarine. The mother submarine will be able to launch and recover the DSRV while submerged and, if necessary, while under ice.

DSRV must hover over a disabled submarine, mate with its escape hatch, and evacuate all personnel. An Integrated Control And Display (ICAD) system will enable the DSRV operator and co-operator to correlate information from sonars, closed circuit television, and advanced navigation devices, in order to perform this intricate rescue mission.

Ultimately, DSRVs could be stationed in pairs at specialized facilities called Rescue Unit Home Ports (RUHP). One DSRV could be on constant alert while its sister craft undergoes readiness maintenance.

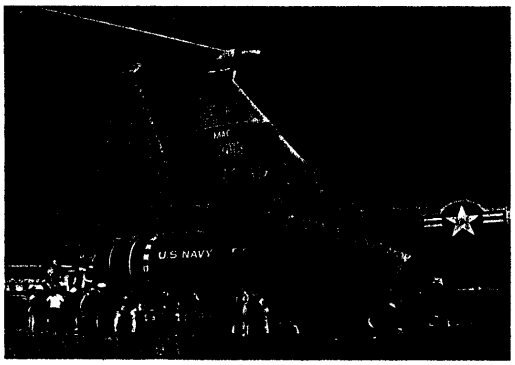
Propulsion and control of the DSRV are achieved by a conventional stern propeller in a movable control shroud, and horizontal and vertical ducted thrusters located forward and aft. This system permits the DSRV to maneuver and hover under adverse conditions of current and enables the submersible to mate with a disabled submarine lying at angles to 45 degrees from the horizontal and the vertical.

The DSRV outer hull is made of fiberglass. Within this outer hull are three interconnected spheres which form the manned pressure capsule. Each sphere is 7½ feet in diameter and is constructed of HY-140 steel. The forward sphere contains the vehicle's control equipment and is manned by the operator and co-operator. The center and after spheres accommodate 24 passengers and a third crewman.

Attached to the underside of the center sphere is a hemispherical "skirt" which seals over the disabled submarine's hatch. During rescue, this skirt is pumped dry to enable personnel to transfer between the DSRV and the submarine.

The DSRV is a torpedo-shaped vehicle built with an inner pressure hull and exterior shell or outer hull, which is open to the sea. Statistics are:

Overall Length	**49 ft. 4 in.**
Diameter at Midbody	**8 ft. 2 in.**
Airborne Weight (C-141)	**68,450 lbs. (est.)**
Diving Trim Weight	**76,657 lbs. (est.)**
Maximum Operating Depth	**5,000 ft.**
Maximum Speed	**4.25 knots**
Maximum Static Pitch Angle	**45 degrees**
Maximum Roll Angle	**45 degrees**
Maximum Hovering Current (Athwartships)	**1 knot**
Maximum Ascent Rate, Maximum Descent Rate	**250 feet per min.**
Number Degrees of Control Freedom	**6 — pitch, roll, yaw, heave, surge, sway**
Number Viewports	**2 forward sphere, 3 midsphere**
Normal Battery Capacity	**81 kilowatt-hours**
Approximate Endurance (3-knot Cruise)	**10 hours**



ARRIVING at San Diego, DSRV-1 is off-loaded following shipment by C-141 from Sunnyvale.

Building the DSRV

DSRV is the first U.S. Navy submersible developed from formal, functional analysis of sub-system requirements. This vehicle, with its 24-passenger payload, is a true advance in the state-of-the-art.

Because the crew of a disabled submarine must be rescued quickly, DSRV must be transported on land, in the air, and at sea both by surface ship and aboard a "mother" submarine, either submerged or surfaced. The DSRV thus finds many of its design constraints in a complex variety of static and dynamic load and environmental conditions.

While searching with its seven sonar systems and five closed circuit TV systems, the DSRV is virtually a mobile sensor platform. Once at the rescue scene, the DSRV must mate with the distressed submarine and transfer personnel at attitudes of plus or minus 45° in roll and pitch and in the presence of ocean bottom currents. To accomplish the mating feat, integrated control of six degrees of motion freedom is provided by an onboard computer through an automatic control system. Among other control modes, this system provides for roll damping, using the transfer of mercury in the vehicle's list system.

The tri-spherical pressure hull and main tankage are made from the first production heats of a new quench-and-temper steel, HY-140, selected for its excellent strength and toughness. The production and fabrication techniques for its use were developed and proved by Lockheed in the DSRV program.

Titanium is also used extensively for the framing of the DSRV outer hull and for selected tankage. The DSRV longerons were the longest titanium extrusions made in the USA, prior to the C-5A program.

The skin of the outer hull is glass reinforced plastic (GRP), and sections of the midbody are some of the world's largest void-free GRP structures ever produced up to that time.

Electrical cabling and terminal connectors exposed to the deep ocean environment represent an advance in the state-of-the-art. The through-hull electrical penetrators were specially developed to provide a high pin density, with redundant seals to assure a fail-safe design. Cabling termination molding techniques are a significant advancement in technology; their qualification includes 2,000 pressure cycles to at least 1½ times the design operating depth.

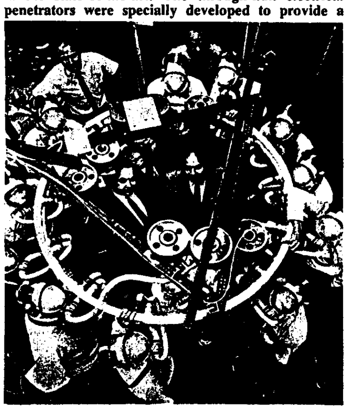
The manipulator used on DSRV is the first undersea application of a six degrees-of-motion arm with a cable cutting capability, true arm motion, and programmed stowage. The manipulator, and all other devices which could become entangled with ocean bottom debris, are jettisonable.

To accomplish this, safety devices developed include highly reliable and redundant undersea pyrotechnics for arm separation; mercury dump valves; and cable cutters.

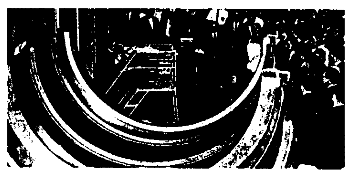
The normal life-support system features automatic control of oxygen partial-pressure in the cabin atmosphere which also incorporates automatic alarms to warn the submersible operators of dangerous conditions.

An emergency life support system is available for crew and passengers. And of the nearly 500 controls and sensor monitors which are provided for the operator's use, many are programmed into the computer system for automatic monitoring and control.

Because of the rigorous operational requirements, severe environments, and tight weight limitations, virtually every component of the DSRV has been a specifically designed or developed item contributing to the vehicle's success.



THIRTEEN MEN test emergency breathing apparatus for DSRV. In the center are Bob Kermeen, DSRV program manager; and Sam Feldman, head of Vehicles Branch, Navy Deep Submergence Systems Project Office.



J. G. "Jim" WENZEL (center foreground, right), manager of Ocean Systems, and Sam Feldman, head of Vehicles Branch, DSSP Office (center foreground, left) are among those on hand at keel laying ceremonies of DSRV-1. E. P. "Elmer" Wheaton, vice president and general manager-R&DD, is at podium.

SECTION OF outer hull is installed on DSRV-1.

INSIDE DSRV-1, fisheye camera lens catches LCDR D. Pat Raetzman (left) and Ward M. Bromaghim, chief electronics technician, at the controls.

The Mission Versatility

Although engineered with emphasis strictly on her primary mission, DSRV is capable of performing tasks other than rescue. This is a direct outcome of the stringent operational requirements of the rescue operation.

A brief inventory of the vehicle capability includes: A two-ton dry payload capacity; extreme navigational accuracy; an extensive sensor suite with redundant and backup systems; several hundred man-hours of life support; a highly advanced manipulator; potential, as modified, of diver lockout to 165 feet or, with modifications, to 600 feet; accessibility to any point in the world's oceans within hours; and independence of wind, weather conditions or ice on the sea surface.

In scientific application, DSRV can acquire environmental data by deploying and collecting instrument packages. It can be equipped as a fully integrated observation platform using instrumentation coupled with photographic, visual, acoustical and mechanical sampling techniques for detailed investigation of selected undersea areas. In experimental missions, DSRV would be a mobile platform for test and evaluation of new materials and finishes as well as sensors, components and equipment.

Recent company-sponsored studies conclusively show that DSRV can be equipped and operated as an effective interim-depth search vehicle. Changing from rescue to search configuration can be rapid, using state-of-the-art equipment with no detriment to rescue capability.

DSRV can carry 24 rescuees (a payload capacity of more than 4100 pounds) and can achieve neutral buoyancy after this payload weight has been discharged. Coupled with her capability to mate and transfer under water, this makes the DSRV an ideal vehicle to provide logistical support for manned undersea stations. With minor modifications and a redesigned transfer skirt, such support missions can be accomplished to depths of 5,000 feet.

Considering her great potential as a useful vehicle for oceanographic investigation, undersea search, and habitat support, DSRV will gather little dust at the Rescue Unit Home Port. She probably will be frequently engaged in operations expanding our knowledge of the marine environment — even as she stands ready for the call to rescue which we hope will never come.

The Important Tasks Ahead

by J. G. "Jim" Wenzel, Manager, Ocean Systems

The DSRV-1 launch represents a major milestone in developing Lockheed's ocean engineering capability and in applying that capability to open the last great frontier of our planet.

DSRV-1 is the second high performance submersible to be designed and built by LMSC, and is the most sophisticated non-combatant submersible system in existence. With the launch behind us we can concentrate on that most important task of demonstrating at sea that we have done our job well.

We are now building a second DSRV that will be tested in late 1970. This vehicle, as well as DSRV-1, will be supported as a Rescue Unit by LMSC in the 1970's in the area of logistic support, inventory control and field engineering. Essential maintenance and logistic support on both vehicles are planned throughout the next decade.

As important as the DSRV is to Lockheed, the U.S. Navy, and this nation, it is only one step in meeting the challenge of exploring the world's oceans and exploiting their resources. The tasks ahead for Lockheed include further development of the deep submersible as a useful tool and applying its technology to both military and commercial undersea systems of the future.

In the near term, our next major step will be in the field of offshore petroleum, i.e., oil well completion and production systems. Our Canadian subsidiary, Lockheed Offshore Petroleum Services, Limited, in Vancouver, is fabricating a prototype system that we will test in mid-1970 under a consortium agreement with several major oil companies. Successful demonstration of this system will lead to production and lease of system hardware and services for operational use during the 1970's, as offshore oil activities continue to grow in importance.

Another area of commercial potential is extraction of economically important minerals from on and under the sea floor by offshore mining. Lockheed's Ocean Systems group is now aggressively studying the technical and economic merits of a deep ocean mining system and anticipates hardware development later this year. Such a mining system could result in significant activity in the extraction of valuable resources from the ocean floor, and substantial expansion of our role as a supplier of undersea system hardware and services.

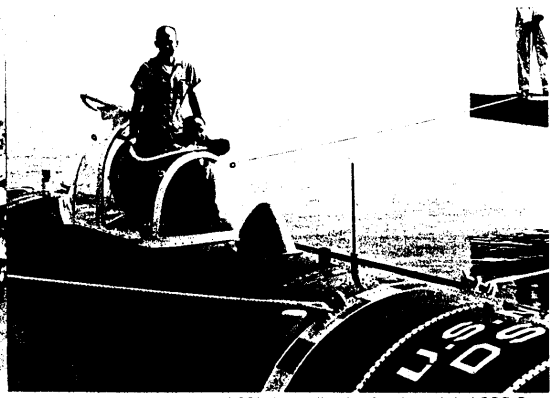
In military systems, Lockheed has won a contract for the development of a new Navy submersible, the Deep Submergence Search Vehicle, capable of operation at depths of 20,000 feet. Although this development has been stretched out by the Navy because of funding constraints, the ultimate technology advancements will enable Lockheed to maintain its leadership in submersible design and construction for many years.

These are a few of our programs. Together with DEEP QUEST operations, they are moving Lockheed into fields as broad and far-reaching as the breadth and depth of the oceans themselves.

And the recent launch of the DSRV-1 is one more important step in our aggressive advance on the vast and challenging business opportunities in the sea.

ON Speakers' Stand, left to right, are Mrs. George Philipps, matron of honor; Captain W. M. Nicholson, director, U.S. Navy's DSSP; Capt. Richard M. Clark, CO, Submarine Flotilla 1; Mrs. O. D. Waters, Jr., sponsor; LCDR Donald Fitzsimmons, Chaplain, Submarine Flotilla 1; Bob Kermeen, program manager, DSRV; Sam Feldman, head of Vehicles Branch, Navy DSSP.

Hon. Bob Wilson



STANDING In canopy of DSRV immediately after launch is LCDR Donald P. Raetzman, officer in charge. In front of him is LMSC Pilot Ron Rau.

DSRV Manager...

(Continued from Page 3)

gram roughly coincided with the calendar years 1967, 1968 and 1969. The launch marked the beginning of the final phase: systems test, sea trials and delivery.

During these five periods (proposal, preliminary design, detail design, fabrication, final assembly and factory test) the dominant role shifted from one organization to another as the functional emphasis shifted. Although program emphasis has changed, the contributions of those who took the lead in the early days of the program are not diminished by the recent, spectacular events of air-lift, launch and sea operations.

The DSRV Program has always been a team effort. Starting with a four-man preproposal group early in 1965, the DSRV proposal team grew along with the early Ocean Systems and Deep Quest organizations. Following receipt of the RFQ in October 1965, an intense 4-month proposal preparation ended with the Evaluation Board review on 26 January 1966.

Essential elements of the Lockheed DSRV win were the strong Ocean Systems technical/management team and the successes of "Deep Quest."

The year 1966 was spent in preliminary design and program definition and culminated in approval of the subsystem design concepts at the final Design Engineering Inspection.

The years 1967 and 1968 were busy with detail design, final interface definition and fabrication. This was also the period of maximum subcontractor and supplier activity.

During late 1968 and early 1969, program emphasis shifted to manufacturing, inspection, and engineering support. The performance of these groups was such that workmanship and hardware quality were cited as contractor strong points in two consecutive Contractor Performance Evaluations for the period from May 1968 to May 1969.

After completion of vehicle assembly in mid 1969, test operations and systems engineering took over lead roles which, together with Ocean Systems' San Diego Operations, will continue through vehicle delivery.

As Program Manager of the DSRV Program, I congratulate all members of the program team. The long hours on the drafting board and the manufacturing floor, the tiresome conferences, the unscheduled trips and the exasperating budget exercises have paid off in the development of a product of which you can all be proud.

You have justified the faith of our customer and our top management in Ocean Systems' ability to complete a tough job. You have proved once again: Lockheed for leadership! You have shown the marine community that Lockheed will be where the action is, anywhere in the ocean, at any depth.

To all of you, my congratulations and thanks!

Ceremony Calls...

(Continued from Page 3)

workmen could assemble the bleachers for spectators and the speakers' stand.

Fresh paint was applied to Transquest, tied up at her pier adjacent to the ramp. Workmen from a shipbuilding company with welders' sparks flying modified the after-deck and elevator well of Transquest so it could carry DSRV-1 to sea and act as tender for builders' trials, scheduled after dockside tests and before the boat will be turned over to the Navy.

Following are excerpts from the speech by Rep. Bob Wilson made at the launching of DSRV-1:

"We know that the sea contains untold resources — untold because we have only rippled the surface. These resources are a million times closer than the moon, but they remain even less accessible — protected by a shield of corrosive, high pressure, opaque sea water.

"Like exploring the moon, the task of getting there demands more resources than can be provided by individuals or even by large commercial concerns . . . The government clearly has a role to lead both exploration and the development in the common interest of mankind.

"This craft is required to perform the most exacting tasks of locating, mating and rescue ever attempted . . . It equals and in many ways exceeds the complexity of the lunar landing problem. The sea contains no navigational references, is impervious to radio communications, and exerts strong random forces on the voyagers. Yet this system . . . will help to open the secrets of the greatest frontier left to mankind.

"As a single unit, it cannot be expected to perform this miracle by itself, but it is the spearhead of a new technology of deep submarine operation; and the lessons learned will make a major contribution to the development of all kinds of submersible equipment.

Deep Quest, its freshly-painted white hull gleaming in the hazy San Diego sun — a whiteness emphasized by the fresh coat of orange on sail and vertical stabilizer — crouched on the Transquest's stern-well in the midst of the activity.

Later that Friday, before the ceremony, Transquest was turned around at the pier so that Deep Quest would have the best seat in the house for the launching.

The whistle and roar of jetliners taking off and landing at San Diego International Airport (Lindbergh Field) across heavily-traveled Harbor Boulevard added a tempo to the activity at LOL. The jetliners brought and carried away a stream of visitors. The visitors were LMSC employes at Sunnyvale and area Navy men working toward the launching.

Launch day dawned overcast and warm. By an hour before the ceremony, the sun had burned its way through and the scene was bathed in a warm winter San Diego sun. A fresh breeze from the north stiffened the 50 state flags that lined the pier, adding more color to the pageant.

The 45-minute ceremony went smoothly. The speaker, Rep. Bob Wilson (R-San Diego), was interrupted only once, by the roar of a big jet getting airborne at the airport. The sponsor, Mrs. O. D. Waters Jr., christened DSRV-1 with champagne, bathing the boat, speakers' stand occupants and nearby photographers in bubbly fizz.

DSRV-1 was eased into the water, and Raetzman emerged from the boat to the cheers of spectators and sat on the bubble that encloses the topside hatch.

DSRV-1 was in its element.

P. W. "PETE" SUMMERS greets Willis M. Hawkins, LAC senior vice president, Science and Engineering; and Admiral John H. Sides, USN Ret., LAC senior Navy Advisor.

A SPEAKER at launch was Admiral I. J. Galantin (left), USN, Chief of Naval Material. With him on speaker's stand was Capt. W. M. Nicholson (right), USN, Director of Deep Submergence Systems Project.

PETE SUMMERS, manager, San Diego Operations, pauses for movie "takes" with Bernie Mahon, 24-10. At camera is Pete Harhay.

During the building of this first DSRV, the Ocean Systems procurement organization issued over 12,000 purchase orders and subcontracts to suppliers in all parts of the country.

Most of these suppliers are in the "small business" category; several were newcomers to the LMSC "supplier family." Regardless of category, they contributed many of the "firsts" recorded by DSRV-1 in techniques developed, in product application, and in the adaptation of space technology to "hydrospace."

As with many other development programs, this one had its share of problems. But our suppliers stepped up to the challenge. And so many contributed to the success of the program that it is impossible to single out one above the other.

But it is most appropriate that Oceans Systems extend its thanks here to this strong group of suppliers who have shown that they can perform competently, and who are ready to perform well on future deep submersible work.